

# Common Ownership, Market Power, and Innovation

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## Abstract

I examine the effects of overlapping ownership on market power when there are external effects across firms. This is done in an oligopoly model with cost-reducing innovation with technological spillovers where firms have an overlapping ownership structure. The model allows for Cournot competition with homogeneous product and for Bertrand with differentiated products as well as for strategic effects of R&D investment. It derives positive testable implications and normative results to inform policy.

*JEL classification numbers:* D43, L13, O32

*Keywords:* competition policy; partial merger; minority shareholdings; cross-ownership; SCP paradigm

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# 1 Introduction

Overlapping ownership of firms in an industry (be it common ownership or cross-ownership across firms) is suspect of relaxing competition and contributing to augmenting the impact of market power in product markets.<sup>1</sup> At the same time it may help internalizing external effects that lead to outcomes suboptimal from the welfare point of view as for example technological spillovers that may be responsible for depressed R&D investment.<sup>2</sup> In this paper I will connect the current debate on the impact of common ownership to the structure-conduct-performance studies of the 1960s and 1970s, and try to assess under what circumstances common ownership is detrimental or beneficial to innovation and welfare, deriving some antitrust implications.

The rise of institutional stock ownership has increased dramatically in the last 35 years, ending the world of dispersed ownership in the US of Berle and Means (1932). Institutional investors such as pension or mutual funds, now have the lion share of publicly traded US firms with a large concentration on the four largest assets managers (BlackRock, Vanguard, State Street and Fidelity). The evolution of the asset management industry, which has become more concentrated and with a shift from active to passive investors, who are more diversified, has changed the ownership structure of firms.<sup>3</sup> Now it is common for large firms in any industry to have common shareholders with significant shares (see, e.g., Azar et al. 2018). Minority cross-ownership is prevalent among many industries as well.

There is vivid debate on whether common ownership relaxes competition. This has been found to hold for the airline and banking industries (Azar et al. 2018), and has been the cause of concern (Elhauge 2016; Baker 2016) resulting in recommendations of antitrust policies that can mitigate the effects of augmenting common ownership (e.g., Elhauge 2016, 2017 on the Clayton Act (S.7) and Sherman Act (S.1)), or that will restrain ownership in oligopolistic industries, so that institutional investors can benefit from a safe harbor (e.g., enforcement of the Clayton Act, Posner et al. 2016).<sup>4</sup> At the same time, antitrust authorities are worried about the impact of mergers on innovation. Indeed, in the decade 2004-2014, the US Department of Justice and the US Federal Trade Commission identified a third of the mergers that they challenged to be detrimental to innovation, while more than

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<sup>1</sup>That common/cross ownership may lead to relaxed competition was already pointed out by Rubinstein et al. (1983).

<sup>2</sup>Socially optimal level of R&D is between two and three times as high as the level of observed R&D because of non-internalized technological spillovers (Bloom et al. 2013).

<sup>3</sup>The first three asset managers have increased their market share adopting passive investment strategies.

<sup>4</sup>These views have been questioned by Rock and Rubinfeld (2017).

80% of the challenged mergers were in industries of high R&D intensity (Gilbert and Greene 2015). More so, "partial" mergers via common ownership are also suspect according to the European Commission (EC).<sup>5</sup> There is a lively debate on whether and when mergers may decrease innovation.<sup>6</sup>

The backdrop of those concerns are trends of increasing aggregate product market concentration (Grullon et al. 2018; Autor et al. 2017; Head and Spencer 2017) and potential increase in market power, resulting in increased economic profits and markups (De Loecker et al. 2018; Hall 2018). There is also the perception of lack of dynamism in Western economies in terms of entry and exit, investment, and innovation (CEA 2016 reports). More in general, the "weak" recovery after the Great Recession associated with the financial crisis has been linked to a potential secular stagnation of advanced economies, declining labor share (Barkai 2016; Autor et al. 2017), and increased market power (Summers 2016, Stiglitz 2017).<sup>7</sup>

In this paper I survey first in Section 2 the potential impact of the changes in ownership structure on the objective of the firm and corporate governance. In Section 3, I discuss the debate on the effects of common ownership taking the perspective of the structure-conduct-performance (SCP) paradigm. In Section 4, I present the oligopoly innovation model with spillovers and flexible ownership structure developed in López and Vives (forth.) with its positive and normative results. Section 5 is devoted to antitrust implications and Section 6 concludes with some open issues.

## 2 Corporate governance and overlapping ownership

While the objective of the firm is clear in a (perfectly) competitive context, to maximize profits for shareholders, in other contexts there is no simple objective function for the firm since high prices may harm shareholders as consumers and firms large in factor and product markets care about price impact.<sup>8</sup> If there is overlapping ownership across firms, the manager of a firm should account for both profits and external effects on other firms. Diversified

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<sup>5</sup>The EC in the Dow-Dupont merger decision in 2017 stated that "the Commission is of the view that (i) a number of large agrochemical companies have a significant level of common shareholding, and that (ii) in the context of innovation competition, such findings provide indications that innovation competition in crop protection should be less intense as compared with an industry with no common shareholding".

<sup>6</sup>See Motta and Tarantino (2018), and Federico et al. (2017).

<sup>7</sup>Azar and Vives (2018, forth.) provide a general equilibrium model to check the macroeconomic effects of common ownership.

<sup>8</sup>According to the Fisher Separation Theorem (Fisher 1930), when firms are price-takers shareholders agree on the profit maximization objective (Hart 1979 extends the result to incomplete markets).

shareholders want a policy of portfolio value maximization and should induce managers to internalize any externality on commonly owned firms (Hansen and Lott 1996, Gordon 2003). Indeed, common owners in an industry may have the ability and incentive to influence management (Posner et al. 2016). This applies also to passive investors (large asset managers) since they are not passive owners as indicated, for example, by the CEO of BlackRock, Larry Fink and available evidence.<sup>9</sup> The issue arises of how strong are the incentives of asset managers to comply with the interests of their clients taking into account they have a fiduciary duty to them. Anton et al. (2017) find that in industries with higher degrees of common ownership, there are weaker incentives for managers to compete (managerial wealth is less sensitive to firm performance).<sup>10</sup>

We make the parsimonious assumption that the manager of a firm maximizes a weighted average of shareholders' utilities.<sup>11</sup> Salop and O'Brien (2000) develop a simple model of common ownership that differentiates between cash flow and control rights, where each investor cares about the total profit of his portfolio. The manager of each firm takes this into consideration by maximizing a weighted (by control weights) average of the shareholders' portfolio profits.

Consider an industry with  $n$  firms and  $I$  owners/investors. Let  $v_{ij}$  be the ownership share (cash flow rights) of firm  $j$  accruing to investor  $i$  and  $\gamma_{ij}$  the control rights of firm  $j$  held by owner  $i$ . The total portfolio profits of investor  $i$  are  $\sum_{k=1}^n v_{ik}\pi_k$ , where  $\pi_k$  are the profits of firm  $k$ . The manager of firm  $j$  maximizes a weighted average of its shareholders' portfolio profits (with weights given by the control rights  $\gamma_{ij}$ ):  $\sum_{i=1}^I \gamma_{ij} \sum_{k=1}^n v_{ik}\pi_k$ , which is proportional to  $\pi_j + \sum_{k \neq j} \lambda_{jk}\pi_k$  where  $\lambda_{jk} \equiv (\sum_i \gamma_{ij}v_{ik}) / (\sum_i \gamma_{ij}v_{ij})$  is the degree of internalization (Edgeworth's coefficient of effective sympathy) of firm  $k$ 's profits by the manager of firm  $j$ .<sup>12</sup> The relative concentration of ownership and control in firm  $k$  versus firm  $j$  is what determines the coefficient's value, which represents the relative weight placed by the manager of firm  $j$  on the profit of firm  $k$  compared to the weight placed on the own firm's profit; it reflects the extent to which investors with financial interests in firms  $j$  and

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<sup>9</sup>See his 2018 annual letter to CEOs. See the evidence of active corporate governance by asset managers in Brav et al. (2018) and Gilje et al. (2018). Appel et al. (2016) find that passive investors are long term, have voice, and improve ROA.

<sup>10</sup>See also Gordon (2003).

<sup>11</sup>Rotemberg (1984) proposed the assumption. This can be rationalized by voting on management strategies/power indexes of shareholders (Azar 2017; Brito et al. 2018). There is evidence that shareholder dissent hurts directors and that director elections matter because of career concerns (Fos and Tsoutsoura 2014, Agarwal et al. 2017). See also Brav et al. (2018).

<sup>12</sup>Also used by Cyert and DeGroot (1973).

$k$  control firm  $j$ .

With proportional control  $\gamma_{ij} = v_{ij}$  a firm’s manager takes into account the firm’s shareholders’ interests in other firms to an extent that is analogous to their stakes in the own firm. Then  $\lambda_{jk} = (\sum_i v_{ij}v_{ik}) / (\sum_i v_{ij}^2)$  where the denominator is the Herfindahl-Hirschman Index (“HHI”) for the investors in firm  $j$ . The higher is  $\lambda_{jk}$  the less concentrated investors in firm  $j$  are, and the more concentrated investors in firm  $k$  are and the more aligned are investors’ stakes in the two firms.<sup>13</sup>

We provide here a stylized symmetric ownership model that encompasses both common ownership and cross-ownership (López and Vives forth). Let there be  $I \geq n$  owners/investors holding common ownership firms’ stakes. The model nests cases of silent financial interests (SFI), where there is ownership without control, and of proportional control (PC).<sup>14</sup> In both cases we assume that there is a reference shareholder for every firm and every investor owns a share  $\alpha$  of the firms that are out of his control.<sup>15</sup> With cross-ownership (CO), each of the  $n$  firms may own shares of rival firms without control rights (e.g., nonvoting shares), in which case  $\alpha$  represents a firm’s ownership stake in another firm, and the controlling shareholder makes the decisions.<sup>16</sup>

In every case, when stakes are symmetric, the manager of firm  $j$  maximizes

$$\phi_j = \pi_j + \lambda \sum_{k \neq j} \pi_k, \quad (1)$$

where  $\lambda$  depends on the ownership structure (in the classical profit maximizing case  $\lambda = 0$ , in a cartel or after a full merger  $\lambda = 1$ ). With common-ownership  $\lambda$  reaches its upper bound  $\lambda = 1$  when  $\alpha = 1/I$ . For  $\alpha < 1/I$ ,  $\lambda$  increases with  $I$  and  $\alpha$ .<sup>17</sup> With cross-ownership  $\lambda$  is the ratio of the stake of firm  $j$  in firm  $k$  over the claims of firm  $j$  on its own and on firm  $k$ ’s profits. With cross-ownership  $\lambda$  reaches its upper bound  $\lambda = 1$  when  $\alpha = 1/(n - 1)$ , and again it holds that  $\lambda$  increases with  $n$  and  $\alpha$ .

Table 1 presents the value of  $\lambda$  for each type of overlapping ownership (SFI, PC, or CO). Notice that more investors and higher investment stakes imply higher  $\lambda$ . In addition, for

<sup>13</sup>See section A.1.1 in the online appendix to López and Vives (forth.).

<sup>14</sup>The model accommodates any structure featuring symmetry. Preserving symmetry, Banal-Estanol et al. (2018) modify the model to allow for a partition of active and passive investors, where the latter’s control is lower than their firm stakes.

<sup>15</sup>The reference shareholder has an interest  $1 - (I - 1)\alpha$  in his firm. Assuming  $\alpha I < 1$  we have that  $1 - (I - 1)\alpha > \alpha$ .

<sup>16</sup>This setting features a chain-effect interaction between the profits of firms (see Giló et al. 2006).

<sup>17</sup>The driving force of the comparative statics result is the decline in the interest in the own firm (undiversified stake) of reference investors  $1 - (I - 1)\alpha$  as  $I$  or  $\alpha$  increase.

a given stake  $\alpha$ ,  $\lambda^{\text{PC}} > \lambda^{\text{SFI}}$  and that for  $I = n$ ,  $\lambda^{\text{SFI}} > \lambda^{\text{CO}}$ . More control leads to more internalization of rivals' profits and, for given silent financial interests, cross-ownership yields the lowest internalization.<sup>18</sup>

	Common Ownership, $v_{ik} = \alpha, \gamma_{ik} = 0$ Silent Financial Interests (SFI)	Common Ownership, $v_{ij} = \gamma_{ij}$ Proportional Control (PC)	Cross-ownership (by firms, CO)
$\lambda$	$\frac{\alpha}{(1-(I-1)\alpha)}$	$\frac{2\alpha[1-(I-1)\alpha]+(I-2)\alpha^2}{[1-(I-1)\alpha]^2+(I-2)\alpha^2}$	$\frac{\alpha}{1-(n-2)\alpha}$

Table 1: Edgeworth simpathy coefficient (different ownership structures)

There is evidence that the weights on rivals' profits (the lambdas) have increased markedly in the US economy (under the assumption of proportional control). Indeed, for the US 1500 largest firms according to market capitalization the estimated average lambdas double from about .35 in 1985 to about .70 in 2015 (Azar and Vives 2018). Banal-Estanol et al. (2018) find that passive investors increased their holdings relative to active shareholders post-crisis (with data for 2004-2012 of all publicly listed firms in the U.S.). In principle, and other things equal, this need not lead to a higher degree of internalization of rivals' profits since passive investors should exert less control than active ones. However, passive shareholders are more diversified and have become more concentrated in the asset management industry. This shift has led to more interconnected networks of common ownership and a potentially higher degree of internalization of rivals' profits. According to Banal-Estanol et al. (2018) the rise in passive investors drives the increase in the lambdas.

### 3 The Structure-Conduct-Performance paradigm revisited

The structure-conduct-performance ("SCP") paradigm in Industrial Organization, which is associated to Bain (1951), was dominant in 1960s and 1970s. According to the market power hypothesis developed by this approach, firms in concentrated markets protected by barriers to entry earn high price/cost margins and profits. It was found in cross section studies of industries that the relation between concentration (measured for example by the HHI) and profitability was statistically weak and the estimated effect of concentration usually small.

<sup>18</sup>In accordance with our results, Anton et al. (2017) show that in industries with increased common ownership (i.e., higher  $\alpha$ ) measures of relative performance are not as commonly used in manager incentivization schemes, which implies that rivals' profits are more strongly internalized.

This approach was criticized by the Chicago school for not modeling the conduct of firms. The apparent correlation between concentration and profitability could be due to the fact, according to the efficiency hypothesis postulated by Demsetz (1973), that large firms are more efficient, command larger price/cost margins and earn higher profits, and therefore concentration and industry profitability go together. Indeed, modern IO analysis points out that margins, market shares, and concentration are jointly determined (see Bresnahan 1989, Schmalensee 1989) and opens the way to careful empirical industry studies. A foundation of the SCP hypothesis can be provided by the Cournot model. The model can be augmented easily to accommodate for overlapping ownership (Reynolds and Snapp 1986, Bresnahan and Salop 1986). The Lerner index of firm  $j$  is given by

$$L_j \equiv \frac{p - C'_j}{p} = \frac{s_j + \sum_{k \neq j} \lambda_{jk} s_k}{\eta},$$

where  $C'_j$  is the marginal cost of firm  $j$ ,  $\eta$  is the elasticity of demand, and  $s_k$  the market share of firm  $k$ . Firm  $j$  enjoys a larger margin when its manager puts more weight on the profits of firms with high market share. In equilibrium, the market share-weighted industry Lerner index is

$$\sum_j s_j (p - C'_j) / p = \text{MHHI} / \eta,$$

where MHHI is the modified HHI:

$$\text{MHHI} \equiv s' \Lambda s = \sum_j \sum_k \lambda_{jk} s_j s_k = \text{HHI} + \Delta,$$

with  $\Delta \equiv \sum_j \sum_{k \neq j} \lambda_{jk} s_j s_k$  a measure of the unilateral anti-competitive incentives due to common ownership.<sup>19</sup>

We can formulate a revised market power hypothesis as follows: Firms in markets with high levels of common/overlapping ownership earn high price/cost margins and profits because of reduced competitive pressure. This amounts to augmenting the traditional SCP regression of margins on the HHI concentration index (and potentially market share) with a MHHI that accounts for overlapping ownership.

Preliminary evidence consistent with such hypothesis, using a modified HHI which accounts for overlapping ownership, is in the work of Azar, Schmalz and co-authors (2018)

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<sup>19</sup>The matrix  $\Lambda$  of sympathy coefficients can accommodate both common and cross-ownership patterns to yield a generalized HHI, GHHI.

for airlines and banking. Those authors use variation in geographic markets and exogenous variation in common ownership patterns due to the acquisition of Barclays Global Investors by BlackRock in 2009. The problem with using the MHHI is that it depends on both the lambdas and the market shares and therefore does not adequately detect casual effects of ownership structure on market power. The early results on airlines and banking have been contested by O'Brien and Waehrer (2017), Dennis et al. (2018), Kennedy et al. (2017), and Gramlich and Grundl (2017). A main idea is that the relation to isolate is between the Edgeworth (1881) sympathy coefficients (out of the ownership structure) and prices/margins. This idea is pursued in a cross section of industries in the work of Banal-Estanol et al. (2018).

Several authors have found economy-wide increases in price/cost margins since the 1980s. De Loecker et al. (2018) find an extraordinary large increase in markups from 21% in 1980 to 61% in 2017 for publicly traded firms; Hall (2018) finds a more moderate increase of markups of about 23% from 1.12 in 1988 to 1.38 in 2015. Common ownership has the potential to explain the increase in markups given the reported increases in profit internalization. For example, and for illustrative purposes, a calibration by Azar and Vives (2018, forth.) of the Edgeworth sympathy coefficients in the US economy in the period 1985-2015 for 1500 public firms (distinguishing between inter- and intra-industry profit internalization) yields that, under the maintained assumption of Cournot competition among firms and accounting for oligopsony power in the labor market, markups have increased from 1988 to 2015, over a 20% increase, a similar amount that the Hall (2018) estimate.

Gutiérrez and Philippon (2016, 2017) find underinvestment (relative to standard valuation measures such as Tobin's Q) in the US since early 2000s and that firms owned by quasi-indexers and belonging to industries that have high concentration and high common ownership drive the investment gap.

Continuing with the analogy with the SCP paradigm (see Vives 2017), we can also formulate a revised efficiency hypothesis as follows: High levels of common/overlapping ownership and efficiency are associated because common/overlapping ownership improves information sharing, firm collaboration, corporate governance (because of, among other reasons, the presence of economies of scale in information production and monitoring an industry), and induces managers to reduce cost and/or improve performance. Large firms have more links due to overlapping ownership, better corporate governance, are more efficient, command larger price/cost margins and earn higher profits. The result is that overlapping ownership

and high price/cost margins and industry profits go together. Autor et al. (2017) argue that globalization and technological change lead to concentration and the rise of “superstar” firms, which have low costs (and a low labor share) and high profits. Furthermore, there is some evidence that cross-held firms have higher market share growth and profitability due to efficiency gains and enhanced innovation productivity. He and Huang (2017) find that US cross-held public firms (1980-2010) have higher market share growth and profitability due to efficiency gains and enhanced innovation productivity (patents per \$ spent in R&D). Geng et al. (2016) find that vertical common ownership links improve the internalization of patent complementarities.

In the next section we present a model that combines the market power impact of overlapping ownership together with a potential internalization effect of technological spillovers.

## 4 A model of innovation with spillovers

The question we want to address is whether overlapping ownership arrangements (OOAs) can help firms to internalize technological spillovers and countervail the reduced incentives they may have to compete.

Consider a symmetric model of cost-reducing R&D investments with spillovers in Cournot or Bertrand oligopoly with (symmetric) overlapping ownership (López and Vives forth.). In the central scenario each firm  $j = 1, \dots, n$  chooses simultaneously R&D  $x_j$  and output (in a homogeneous product market)  $q_j$  or price (in a differentiated products market)  $p_j$ , and the manager of the firm maximizes

$$\phi_j = \pi_j + \lambda \sum_{k \neq j} \pi_k,$$

where  $\lambda$  depends on the type of common/cross-ownership in the industry.

Marginal production cost  $c(\cdot)$  for each firm  $j$  is constant with respect to output and depends on own R&D effort  $x_j$  and rivals’ aggregate effort  $\sum_{k \neq j} x_k$ :

$$c(x_j + \beta \sum_{k \neq j} x_k) \text{ with } c' < 0, c'' \geq 0 \text{ (} j \neq k \text{)}.$$

where  $\beta \in [0, 1]$  is the spillover coefficient of the R&D activity. According to Bloom et al. (2013) the average sensitivity of the stock of knowledge of firm  $j$  in relation to the R&D investment of  $k \neq j$  is between .4 to .5. The cost of investment is given by  $\Gamma(x_j)$  with  $\Gamma' > 0$

and  $\Gamma'' \geq 0$ . The profit of firm  $j$  (producing output  $q_j$ ) is thus given by

$$\pi_j = \text{Revenue} - c(x_j + \beta \sum_{k \neq j} x_k)q_j - \Gamma(x_j).$$

We assume that there is a unique regular symmetric interior equilibrium with quantity  $(q^*, x^*)$  or price  $(p^*, x^*)$  competition.<sup>20</sup> The FOC with respect to R&D at a symmetric equilibrium is

$$-c'(Bx^*) (1 + \lambda\beta(n-1)) q^* = \Gamma'(x^*),$$

where  $B \equiv 1 + \beta(n-1)$ .

With quantity (Cournot) competition we assume that there is a homogeneous good with smooth inverse demand function  $f(Q)$ ,  $f' < 0$ , where  $Q$  is the total output, with constant relative degree of convexity  $Qf''/f' = \delta$ . This formulation allows for log-concave and log-convex demands (e.g., linear, as in d'Aspremont and Jacquemin (1988), Kamien et al. (1992); constant elasticity as in Dasgupta and Stiglitz (1980)). The revenue of firm  $j$  is given by  $R(q_j; q_{-j}) = f(Q)q_j$  and the FOC with respect to output yields the modified Lerner formula

$$\frac{f(Q^*) - c(Bx^*)}{f(Q^*)} = \frac{\text{MHHI}}{\eta(Q^*)},$$

where  $\eta$  as before is the elasticity of demand,  $\text{MHHI} = \text{HHI} + \Delta$  and  $\Delta = \frac{\lambda(n-1)}{n}$  yielding

$$\text{MHHI} = \frac{1 + \lambda(n-1)}{n}.$$

Our general model nests the R&D model specifications of: (i) d'Aspremont Jacquemin (AJ), where demand is linear (and thus log-concave), as is the marginal production cost function  $c(\cdot)$ , and the R&D cost function  $\Gamma(\cdot)$  is quadratic, (ii) Kamien Muller Zang (KMZ), and (iii) a constant elasticity (CE) model with log-convex demand similar to Dasgupta and Stiglitz (1980) but including R&D spillovers. In both KMZ and CE,  $c(\cdot)$  is strictly convex and  $\Gamma(\cdot)$  linear. In all cases (with inverse elasticity of demand less than one for CE) outputs are strategic substitutes given that  $\delta > -2$ .

With price (Bertrand) competition we assume that the industry has  $n$  differentiated products, each produced by one firm. The demand for good  $j$  is given by  $q_j = D_j(\mathbf{p})$ , where  $\mathbf{p}$  is the price vector, and for any  $j$ ,  $D_j(\cdot)$  is smooth whenever positive, downward sloping,

<sup>20</sup>We assume that the Jacobian of the FOC at the symmetric solution is negative definite.

with strict gross substitutes  $\partial D_k/\partial p_j > 0$ ,  $k \neq j$ , and the demand system  $D(\cdot)$  is symmetric with negative definite Jacobian. The revenue of firm  $j$  is given by  $R(p_j; p_{-j}) = p_j D_j(\mathbf{p})$  and the FOC with respect to price yields a modified Lerner formula

$$\frac{p^* - c(Bx^*)}{p^*} = \frac{1}{\eta_j - \lambda(n-1)\eta_{jk}},$$

where  $\eta_j = -\frac{\partial D_j(\mathbf{p}^*)}{\partial p_j} \frac{p^*}{D_j(\mathbf{p}^*)}$  is the own elasticity of demand and  $\eta_{jk} = \frac{\partial D_k(\mathbf{p}^*)}{\partial p_j} \frac{p^*}{D_k(\mathbf{p}^*)} > 0$ ,  $k \neq j$  the cross-elasticity.

An example is provided by the analogous to the d'Aspremont and Jacquemin (1988) model with (symmetric) product differentiation:

$$D_i(p) = a - bp_i + m \sum_{j \neq i} p_j$$

with  $a, b, m > 0$ , arising from a representative consumer with quasilinear utility, innovation function  $c_i = \bar{c} - x_i - \beta \sum_{j \neq i} x_j$ , and investment cost  $\Gamma(x) = (\gamma/2)x^2$ .<sup>21</sup>

## 4.1 The comparative statics of profit internalization

For a given  $x$ ,  $\lambda$  has a negative (positive) effect on quantity (price) because products are gross substitutes:<sup>22</sup>

$$\partial_{\lambda q_j} \phi_j < 0 \text{ and } \partial_{\lambda p_j} \phi_i > 0.$$

This is the relaxing effect of profit internalization of rivals on competition. For a given quantity/price,  $\lambda$  has a positive effect on investment if there are spillovers,  $\beta > 0$ :

$$\partial_{\lambda x} \phi_j = -\beta q(n-1)c' > 0.$$

This is the internalization effect of overlapping ownership on R&D effort in the presence of spillovers. The total impact of  $\lambda$  on the equilibrium values of quantity/price and R&D will depend on which of the two effects dominates.

We have also that

$$\partial x^*/\partial \lambda \leq 0 \implies \partial q^*/\partial \lambda < 0, \partial p^*/\partial \lambda > 0,$$

<sup>21</sup>See Section 5 in López and Vives (forth.) for a constant elasticity example with non-quasilinear utility.

<sup>22</sup>Second-order derivatives are denoted by  $\partial_{z_i z_j} \phi_i \equiv \partial^2 \phi_i / \partial z_i \partial z_j$  and  $\partial_{h z_i} \phi_i \equiv \partial^2 \phi_i / \partial h \partial z_i$  (with  $h = \beta, \lambda$ , and  $z = q, p, x$ ).

because price (output) and R&D are substitutes (complements) for a firm.

Let  $E$  denote an index of equilibrium effectiveness of R&D. When  $\Gamma''(x^*) > 0$ , let

$$E \equiv \xi(q^*, x^*) \left( 1 + \frac{\chi(Bx^*)}{y(x^*)} \right)^{-1} > 0,$$

where

- $\chi(Bx^*) \equiv -c''(Bx^*)Bx^*/c'(Bx^*) \geq 0$  is the elasticity of the slope of the innovation function (relative convexity of  $c(\cdot)$ ).
- $y(x^*) \equiv \Gamma''(x^*)x^*/\Gamma'(x^*) \geq 0$  is the elasticity of the slope of the investment cost function.
- $\xi(q^*, x^*) > 0$  is the relative effectiveness of R&D (Leahy and Neary 1997).

We assume that  $E(\beta, \lambda)\beta$  is increasing in  $\beta$  and  $E(\beta, \lambda)$  decreasing in  $\lambda$  (this holds in the model specifications).

López and Vives (forth.) show that we can partition then spillovers in potentially three regions with different comparative statics:

$$\begin{array}{ccc} \text{R}_I: \frac{\partial x^*}{\partial \lambda} \leq 0, \frac{\partial q^*}{\partial \lambda} < 0 & \text{R}_{II}: \frac{\partial q^*}{\partial \lambda} \leq 0, \frac{\partial x^*}{\partial \lambda} > 0 & \text{R}_{III}: \frac{\partial q^*}{\partial \lambda} > 0, \frac{\partial x^*}{\partial \lambda} > 0 \\ \hline & \underline{\beta}(\lambda) & \beta'(\lambda) & \beta \end{array}$$

We have that the thresholds  $\underline{\beta}(\lambda)$  and  $\beta'(\lambda)$  are increasing in the level of market concentration in the Cournot case;  $\beta'(\lambda)$  is weakly increasing in  $\lambda$  and decreasing in the effectiveness of R&D  $E$ . Furthermore, in all the model specifications we have that the degree of profit internalization and the degree of spillovers are complements in fostering R&D,  $\partial x^*/\partial \lambda \partial \beta > 0$ . A higher level of spillovers makes raising  $\lambda$  more effective in increasing  $x^*$ .

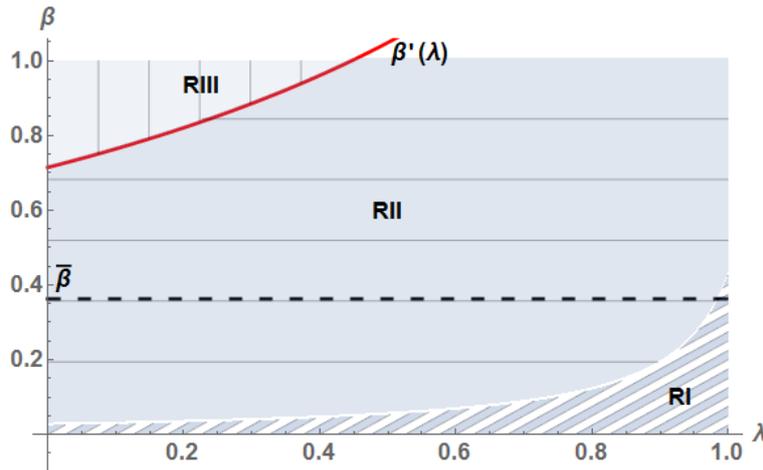


Figure 1: Regions for spillover thresholds in the space  $(\lambda, \beta)$  for the linear Bertrand model.<sup>23</sup>

Equilibrium profits  $\pi^*(\lambda)$  are increasing in  $\lambda$ . In the Cournot case we can show that

$$\text{sign}\{\pi^{*\prime}(\lambda)\} = \text{sign}\left\{-\beta c'(Bx^*)\frac{\partial x^*}{\partial \lambda} + f'(Q^*)\frac{\partial q^*}{\partial \lambda}\right\}. \quad (2)$$

In  $R_{II}$  the result is clear since then  $\partial x^*/\partial \lambda > 0$  and  $\partial q^*/\partial \lambda < 0$ . In  $R_I$  the positive effect on price dominates the negative effect on R&D, and conversely in  $R_{III}$ , so that profits in both regions rise with the level of overlapping ownership. Investors and firms always have incentives to increase their interdependence provided the agreements are *binding*. With dynamic interaction in a symmetric case, Gilo et al. (2006) find that with stakes high enough tacit collusion is facilitated by cross-ownership deals, as incentives to deviate are attenuated. In the Bertrand case the result can be checked also the linear or constant elasticity specifications.

The following testable predictions follow:

- a positive relationship between overlapping ownership and R&D is expected in industries with high enough spillovers and low enough concentration;
- this positive relationship should also hold for output in industries with high effectiveness of R&D;
- the impact of overlapping ownership on R&D should be higher when spillovers are high;
- industry profits should increase with the extent of overlapping ownership.

It is worth noting that we may have that while margins go up, prices go down because R&D investment grows and marginal production costs diminish. This tends to happen when spillovers ( $\beta$ ) are large.

## 4.2 Welfare Analysis

Let  $W(\lambda)$  denote total surplus (TS) and  $CS(\lambda)$  consumer surplus (CS) evaluated at the equilibrium for a given  $\lambda$ . We have then that

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<sup>23</sup>For  $a = 700$ ,  $\bar{c} = 600$ ,  $b = 1.4$ ,  $m = 0.12$  and  $n = 8$  (Fig. B1 in online appendix of López and Vives (forth)).

$$\text{sign} \{W'(\lambda)\} = \text{sign} \left\{ v(q^*; \lambda) \frac{\partial q^*}{\partial \lambda} + (1 - \lambda)\beta(n - 1) |c'(Bx^*)| \frac{\partial x^*}{\partial \lambda} \right\}$$

where  $v(q^*; \lambda) > 0$  (both with Cournot or Bertand competition). In  $R_I$  we have that  $W'(\lambda) < 0$  because  $\partial x^*/\partial \lambda \leq 0$  and  $\partial q^*/\partial \lambda < 0$ ; in  $R_{III}$ ,  $W'(\lambda) > 0$  because  $\partial x^*/\partial \lambda > 0$  and  $\partial q^*/\partial \lambda > 0$ . In  $R_{II}$ , however, the effect of  $\lambda$  on welfare is positive or negative according to whether the positive effect of overlapping ownership on R&D does or does not dominate its negative effect on the output level. Moreover, the effect of  $\lambda$  on CS is positive (i.e.,  $CS'(\lambda) > 0$ ) only when  $\partial q^*/\partial \lambda > 0$  (i.e., in  $R_{III}$ ).

López and Vives (forth.) obtain the following result. In the Cournot case, if  $\delta > -2$ , total welfare is single peaked in  $\lambda$ , and under the regularity assumptions on R&D effectiveness there are threshold values  $\bar{\beta} < \beta'(0)$  such that:

$$\begin{array}{c} \lambda_{TS}^o = \lambda_{CS}^o = 0 \quad \lambda_{TS}^o > \lambda_{CS}^o = 0 \quad \lambda_{TS}^o \geq \lambda_{CS}^o > 0 \\ \hline \beta \qquad \qquad \qquad \beta'(0) \qquad \qquad \qquad \beta \end{array}$$

In all cases, the CS standard is more stringent than the TS standard. That is, the former allows less rivals' profit internalization than the latter:  $\lambda_{TS}^o \geq \lambda_{CS}^o$ . Furthermore, whenever  $\lambda_{TS}^o \in (0, 1)$  and  $\lambda_{CS}^o \in (0, 1)$ , then

- $\lambda_{TS}^o$  and  $\lambda_{CS}^o$  are both strictly increasing in  $\beta$ ;
- $\lambda_{TS}^o$  is positively associated with R&D effectiveness;
- $\lambda_{TS}^o$  increases with  $n$ , the elasticity of demand and of the innovation function (according to simulations in the models).

In the model specifications, both  $\bar{\beta}$  and  $\beta'(0)$  are decreasing in  $n$ .

The picture that emerges is that a higher level of spillovers makes optimal a higher degree of rivals' profit internalization. More concentrated markets call for less profit internalization.

It is worth noting that increases in  $\lambda$  can be understood as partial mergers and that  $\lambda = 1$  represents a full merger to monopoly (or cartelization). In some circumstances the latter is welfare-optimal. In AJ and KMZ, the consumer surplus solution is a corner (either 0 or 1) under either model specification and we get  $\lambda_{TS}^o = \lambda_{CS}^o = 1$  for  $\beta$  large. This is not the case in the CE model. We can also look into the scope for a Research Joint Venture (RJV). An RJV can be interpreted as a case of full spillovers (i.e.,  $\beta = 1$ ). Then, an RJV

can be optimal only given existence of  $R_{III}$  for  $\beta$  large and provided that  $\partial q^*/\partial\beta > 0$  and  $\partial x^*/\partial\beta > 0$  (which holds if the innovation function's curvature is not too large). In those circumstances a cartelized RJV ( $\lambda = \beta = 1$ ) is optimal in terms of consumer and total surplus. This is the case in the AJ and KMZ models when  $R_{III}$  exists, however  $\lambda = 1$  is never optimal in the CE model.<sup>24</sup>

Similar results obtain for Bertrand models (linear and constant elasticity). The Bertrand model also allows us to check the effect of product differentiation. In this case competition can be intensified through an increase in the degree of substitutability among the products, while the number of firms is kept constant. In this way we can identify the effect of the degree of rivalry. In Figure 2 we see that both  $\lambda_{TS}^o$  and  $\lambda_{CS}^o$  have a U-shaped relationship with respect to the degree of product substitutability in the linear case. Indeed, both  $\lambda_{TS}^o$  and  $\lambda_{CS}^o$  tend to 1 as products become independent and they both increase also as they tend to perfectly homogeneity. Indeed, when products are independent (with well-defined local monopolies) and  $\beta > 0$  we have that  $\lambda_{TS}^o = \lambda_{CS}^o = 1$ . This is so since with local monopolies, increasing  $\lambda$  does not affect the degree of monopoly and helps firms internalize the investment externality provided that there are spillovers  $\beta > 0$ . In short, the impact of competition intensity (i.e., the extent of product differentiation) on the optimal level of rivals' profit internalization is usually non-monotone.

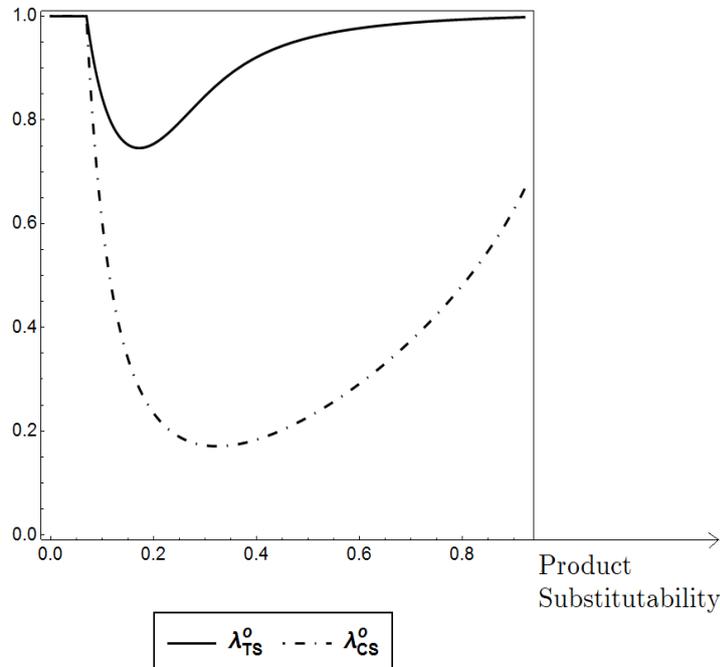


Figure 2: Optimal  $\lambda_{TS}^o$  and  $\lambda_{CS}^o$  in the linear Bertrand model.<sup>25</sup>

<sup>24</sup>Under alternate conditions, a RJV with no overlapping ownership ( $\lambda = 0$  and  $\beta = 1$ ) can be socially optimal in all three models.

<sup>25</sup>For  $\beta = 0.9$ ,  $n = 8$ ,  $a = 700$ ,  $\bar{c} = 500$ , and  $\gamma = 60$  (Fig. B6b in online appendix of López and Vives

## 5 Strategic Commitment

On occasions R&D can be used as a strategic tool by a firm trying to influence market outcomes. This is naturally modeled as a two-stage game where in the first stage, firm  $j$  commits to invest  $x_j$  in R&D and in the second stage, and for given R&D expenditures, firms compete in the product market (be it in quantities or prices). Let  $\mathbf{z}^*(\mathbf{x})$  be the second-stage (quantity or price) equilibrium as a function of the vector  $\mathbf{x}$  of R&D choices. We look for subgame-perfect equilibria (SPE) of the game. The FOC with respect to R&D is for  $j = 1, \dots, n$ :

$$\frac{\partial}{\partial x_j} \phi_j(\mathbf{z}^*(\mathbf{x}), \mathbf{x}) + \underbrace{\sum_{k \neq j} \frac{\partial}{\partial z_k} \phi_j(\mathbf{z}^*(\mathbf{x}), \mathbf{x}) \frac{\partial}{\partial x_j} z_k^*(\mathbf{x})}_{\psi^J} = 0.$$

The term  $\psi^J$  is the strategic effect of investment with  $J = C$ , with  $\partial \phi_j / \partial q_k < 0$ , for Cournot and  $J = B$ ,  $\partial \phi_j / \partial p_k > 0$ , for Bertrand,  $k \neq j$  and when  $\lambda < 1$ . Evaluated a symmetric equilibrium, it is crucial to compare the simultaneous and two-stage models:

$$\text{sign } \psi^C = \text{sign} \{-\partial q_j^* / \partial x_k\} = \text{sign} \{\tilde{\beta}^C(\lambda) - \beta\}$$

$$\text{sign } \psi^B = \text{sign} \{\partial p_j^* / \partial x_k\} = \text{sign} \{\tilde{\beta}^B(\lambda) - \beta\}$$

With Cournot we have that  $\tilde{\beta}^C(\lambda) > 0$  if and only if quantities are strategic substitutes (with  $\tilde{\beta}^C(\lambda)$  increasing with  $\lambda$ ,  $\tilde{\beta}^C(1) = 1$ ) and with Bertrand we have that  $\tilde{\beta}^B(\lambda) < 0$  typically (e.g., for the linear and constant elasticity specifications, where  $\tilde{\beta}^B(\lambda)$  is also increasing in  $\lambda$ ).<sup>26</sup> With low spillovers ( $\beta$ ) and/or a high degree of overlapping ownership in Cournot we have typically that  $\psi > 0$  and there are incentives to overinvest (top dog strategy). In Cournot with high spillovers and/or a low degree of overlapping ownership and in Bertrand, we have that  $\psi < 0$  typically and there are incentives to underinvest (puppy dog strategy). In the first (second) case output and R&D are higher (lower) in the two-stage model than in the simultaneous model. In summary, the strategic effect of investment leads to underinvestment incentives (puppy dog) with high spillovers in Cournot, and more generally for Bertrand competition (regardless of spillovers); and to overinvestment

(forth)).

<sup>26</sup>Sufficient conditions for  $\partial p_j^*(\mathbf{x}) / \partial x_k < 0$  are that  $\beta$  is high and prices are strategic complements; then increasing  $x_k$  decreases the prices of rivals because a larger  $x_k$  shifts the price best reply of firm  $j$  inwards as  $\partial^2 \phi_j / \partial x_k \partial p_j < 0$  as well as as does to the price best reply of firm  $k$  since  $\partial^2 \phi_k / \partial x_k \partial p_k < 0$ .

incentives (top dog) with a high degree of overlapping ownership for Cournot competition.

The welfare analysis is generally robust to the two-stage R&D commitment model with two caveats:

1. The two-stage  $\lambda_{TS}^o, \lambda_{CS}^o$  tend to be higher than in the simultaneous model (larger when spillovers are high since then firms have incentives to underinvest. For example, in the AJ model we have always that  $\lambda_{TS}^o$  and  $\lambda_{CS}^o$  are weakly larger in the two-stage case.
2. We may have  $\lambda_{CS}^o > \lambda_{TS}^o$  in the Cournot model when the strategic effect is positive (then there may be overproduction from the TS perspective due to overinvestment).

The marginal impact of  $\lambda$  on  $W$  (total surplus) adds a strategic investment term  $\omega(\lambda) (\tilde{\beta}(\lambda) - \beta)$ :

$$\begin{aligned} \text{sign } \{W'(\lambda)\} = \\ \text{sign } \left\{ v(q^*; \lambda) \frac{\partial q^*}{\partial \lambda} + \left[ (1 - \lambda)\beta - \omega(\lambda) (\tilde{\beta}(\lambda) - \beta) \right] (n - 1) |c'(Bx^*)| \frac{\partial x^*}{\partial \lambda} \right\} \end{aligned}$$

with  $v, \omega > 0$ , with different expressions for Cournot or Bertrand competition.

When the strategic effect is negative ( $\beta > \tilde{\beta}(\lambda)$ ), the two-stage model behaves like the simultaneous model in the sense that  $W'(\lambda) < 0$  in  $R_I$ ,  $W'(\lambda) > 0$  in  $R_{III}$ , and  $W'(\lambda) \leq 0$  (depending on the strength of spillovers) in  $R_{II}$ , but there are higher social incentives for increasing  $\lambda$  since the impact of  $\lambda$  on R&D and welfare is enhanced. When the strategic effect is positive ( $\beta < \tilde{\beta}(\lambda)$ ) and spillovers are sufficiently low (but not necessarily close to zero)  $W'(\lambda) < 0$  in  $R_{II}$ , and  $W'$  can be positive or negative in  $R_I$  and  $R_{III}$ . Then, the impact of  $\lambda$  on R&D is diminished and in contrast to the simultaneous model, with Cournot competition we may have that for some spillover values  $\lambda_{CS}^o = 1 > \lambda_{TS}^o > 0$  (e.g., in the AJ model for intermediate values of spillovers, see Figure 3).

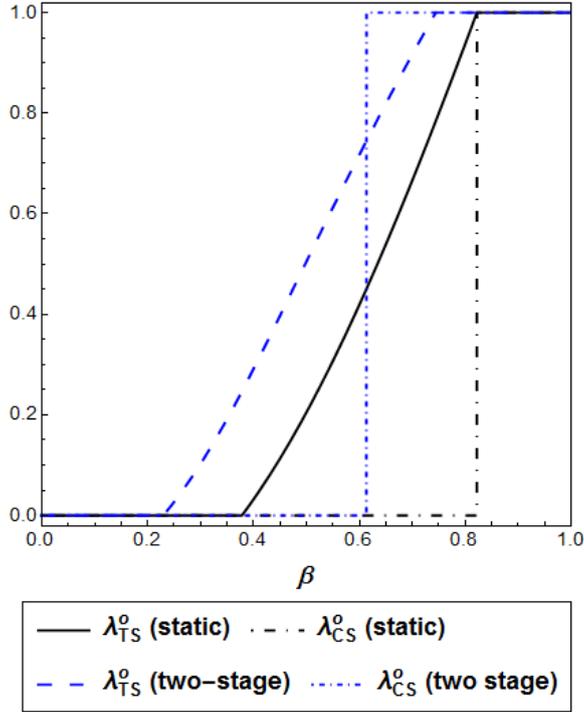


Figure 3: Socially optimal level of overlapping ownership in the two-stage AJ model.<sup>27</sup>

## 6 Antitrust Implications

The antitrust concerns on OOAs has arisen out of the rapid growth of common ownership in industries with stakes in competing firms as well as the growth of private equity investment firms holding partial ownership interests in competing firms. Some high profile cross-ownership cases, such as Ryanair’s acquisition of Aer Lingus’s stock have also attracted attention. In the US, OOAs can be challenged under the Clayton Act (S. 7) and the Hart-Scott-Rodino Act if they substantially lessen competition. The EU Merger Regulation is limited to acquisitions that confer control and is narrower than Section 7 of the Clayton Act. The EC has proposed extending the scope of merger regulation to examine the acquisition of minority shareholdings. The jury is still out on the potential anticompetitive effects of common ownership. The key to having a holistic view is to look not only at prices and quantities but also at innovation and other strategic variables of firms.

In Section 4 we have found that OOAs may be welfare improving in particular when spillovers are high and R&D investment has commitment value since in this case firms have strong incentives to underinvest. When spillovers are high and the curvature of the innovation function low, a cartelized RJV (or full merger with internalization of technological

<sup>27</sup>In the AJ model:  $f(Q) = a - bQ$ ,  $a, b > 0$ ,  $c = \bar{c} - x_i - \beta \sum_{j \neq i} x_j$ , and  $\Gamma(x_i) = \gamma x_i^2 / 2$ . We have that  $a = 700$ ,  $b = 0.6$ ,  $\bar{c} = 500$ ,  $\gamma = 7$  and  $n = 6$  (Fig. A12 in online appendix of López and Vives (forth)).

spillovers) may be welfare-optimal. Inspection of OOAs by antitrust authorities is most warranted for industries with high concentration, since increased concentration (i.e., HHI) expands the region of spillover values for which OOAs are welfare-decreasing, thus, making it more likely that OOAs will be so. Thorough examination of OOAs is also required for low-spillover industries (which can typically be identified as those industries that have low R&D levels or tight patent protection), as in such industries the spillover is more likely to be below the spillover threshold (below which OOAs are welfare-decreasing). In most cases a consumer surplus standard tightens the conditions for OOAs to be welfare-improving, which can exacerbate the tension in competition policy given that authorities follow a consumer surplus standard but at the same time permit high degrees of OOAs and R&D collaboration. Even though mergers can lead to technological spillovers internalization, they increase concentration, which renders OOAs having anti-competitive effects more likely. Therefore, proposals of softer competition policy regarding mergers when overlapping ownership is high (e.g., Posner et al. 2016) should be carefully examined.

Finally, competition policy should distinguish among cases of overlapping ownership according to the degree of control they imply and to whether they stem from common or cross ownership. This is so because the same extent of shareholding will lead to different degrees of internalization of rivals' profits for the different cases above. For example, if the regulator wants to establish a cap on the degree of sympathy between firms, this will imply a more strict cap on shareholdings that confer more control or that are (silent) cross-shareholdings among firms.

## 7 Open issues

Work on common ownership has progressed a lot recently but much more needs to be done. First, we need to have a better understanding of the channels of transmission of ownership patterns into competitive outcomes, via corporate governance; both in terms of theory and empirics we need to understand how cash flow rights translate into control rights. Second, on the theoretical front, we need to deal with asymmetries in firms' characteristics and ownership structure, endogenizing it, and consider general equilibrium implications of common ownership (see Azar and Vives 2018, forth.). Third, we need to refine the empirical methods and draw from the state of the art empirical IO literature to study both specific industries and a cross-section of them (see Banal et al. 2018) since it does not seem enough

for policy design to thoroughly study industries with a minor impact in the economy.

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